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JOB SEARCH, HOURS RESTRICTIONS AND DESIRED HOURS OF WORK

by

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Abstract

We present a structural empirical job search model in which job offers are characterized by a wage rate and the length of the working week. The unemployed accept a job if the direct utility level of the wage-hours combination is higher than the reservation utility level. The latter is determined by the direct utility of being unemployed (depending on the value of leisure and the benefit level) and the expected gains of search. Specific attention is paid to identification, since the observed hours distribution is determined both by the hours offer distribution and by preferences over hours. To identify the hours offers and the optimal hours (defined by preferences) separately, we use information on desired working hours. We estimate three model variants: a base specification with only information on observed working hours, and two variants with desired hours, which differ from each other in the way in which the relation between desired hours and optimal hours is modeled. We compare the various specifications on basis of differences in the fit of the distribution of unemployment duration, observed working hours and desired working hours and on basis of differences in policy relevant elasticities.

[1] We are greatly indebted to Statistics Netherlands for providing the data
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1 Introduction

Early empirical studies in the field of labour supply (e.g. Heckman (1974) and Hausman (1980)) typically focussed on the neo-classica1 labour supply model. In these studies the labour supply function, defined by the tangency point of the indifference curve and the budget constraint, is parametrized, while data on observed weekly hours of work are used to estimate the parameters of the labour supply function. The work by Hausman (1980) made the neo-classical labour supply model a popular tool for the analysis of the relation between taxes and the supply of labour and has been applied to data for many different countries.

Nevertheless it was recognized that observed labour supply may not match the concept of optimally chosen hours generated by the neo-classical labour supply model. The model typically ignores restrictions on working hours that may stem from the demand side of the labour market: in the empirical implementation of the model it is assumed that there are no systematic differences between observed working hours and optimal working hours. The model does not account for 'involuntary' unemployment. It does not incorporate that the number of jobs available are limited, that hours in a job offer are often fixed by the employer, and that it takes time to search for and find an acceptable job. It was noticed that the neo-classica1 labour supply function could not reasonably mimic the peak in the frequency of observed working hours at institutionally determined levels of working hours like 40 hours a week.

This created an incentive to collect subjective survey information on 'desired' weekly working hours. Ham (1982) uses survey information on underemployment as additional information in estimating labour supply. Kahn and Lang (1991) use information on desired weekly working hours to test for systematic differences between observed working hours and desired working hours. Other studies took the neo-classica1 labour supply model as point of departure, but estimated it with subjective data on preferred hours, instead of observed hours. An example of this approach is Woittiez and Kapteyn (1998).[3]

An alternative approach is described in a series of studies (Dickens and Lundberg

[3] The focus in Woittiez and Kapteyn (1983) is on the incorporation of interdependent preferences and habit formation, as an alternative extension of the standard neo-classical labour supply model.

(1993), Tummers and Woittiez (1991), Van Soest, Woittiez and Kapteyn (1990), Bloemen (2000)) in which job offers are modeled explicitly: individuals receive a random number (possibly zero) of job offers, characterized by a wage rate and a weekly number of working hours, from which they select the job with the highest utility. They will decide to work if the job provides a higher utility leve1 than the utility of being jobless. Cross section data on observed working hours and wages are used to estimate the model. The hours offer distribution is typically modeled as a discrete distribution, and as a consequence the models mentioned do rather well in mimicking the empirical distribution of observed weekly working hours. Identification issues in this class of models deserve more attention. First, the model requires the specification of the probability distribution of the number of job offers. However, estimation proceeds without the use of any information on numbers of job offers (or, alternatively, on time elapsed before a job offer or a transition occurs). Bloemen (2000) illustrates the identification problem, by introducing observed heterogeneity in the job offer arrival rate:[4] it results in a distribution of optimal working hours that is approximately uniform over the relevant range of hours. This means that no information on preferences can be subtracted from the data anymore once it is allowed for more flexibility in the job offer probability. Second, both offered hours and optimal hours are identified from data on observed working hours only. This attributes to the identification issue raised first.

In the present paper, both of the identification issues mentioned are addressed. We formulate a sequentia1 job search model, in which individuals receive job offers across time according to a Poisson distribution. A job offer consists of a wage rate and a weekly number of working hours and arrives randomly from a wage-hours offer distribution. Data on unemployment duration as well as information on observed hours and wages is used to identify the job offer arrival rate and the offer distribution. In addition, subjective information on desired weekly working hours is used as additional information to identify the parameters of the utility function. We show what is the differential impact of adding

[4] The previous studies mentioned typically assumed the job offer arrival rate to be identical for every individual, and imposed a constraint on the maximum number of job offers possible. A job offer arrival rate that depends on observed individual characteristics is quite common in empirical implementations of job search models since the work by Narendranathan and Nickell (1985).

this information and we present several approaches to model desired hours.

From the point of view of job search theory (see Mortensen (1986) for an overview) the model is an extension of the standard job search framework in which usually the wage is the distinguishing feature of the job and the individual's decision is based on the expected discounted future income stream.[5,6] Bloemen (1994) showed that this approach can be justified if individuals are not subject to hours constraints. In that case there are no systematic differences between observed working hours and the labour supply function. The latter specifies working hours as a function of the wage. Consequently, the intratemporal utility function in the standard job search framework may be interpreted as an indirect utility function, depending on the wage. Bloemen (1997) estimates a structural job search model in which hours can be chosen optimally and which consequently still has the reservation wage property. Bloemen (1994) showed that if the indvidual is subject to hours restrictions, the job acceptance decision will be characterized by a unique reservation utility level, instead of a unique reservation wage, which can be transformed to a reservation wage rate as a function of working hours. This function takes a minimum in optimal working hours, indicating that, given everything else, a job with optimal working hours will be acceptable at lower wage rates than any other job.

In the next section the model is presented. Section 3 provides a description of the available data. Section 4 contains the results, while section 5 presents an alternative specfication for modelling desired hours and finally, in section 6 we present conclusions.

2 The model

In section 2.1 we formulate the job search model with hours restrictions. In section 2.2 we choose functional forms and distributions of error terms which we use in the empirical specification. In section 2.3 we discuss the formation of the likelihood contributions that

[5] In empirical implementations of structural search models, the utility function is usually simply equal to the wage income or a logarithmic transformation of the wage income. A consequence is that the impact of observed individual characteristics on unemployment duration runs through the job arrival rate and the wage offer distribution, but not through preferences. The approach in the present paper relaxes this restriction as well.

[6] Burdett and Mortensen (1978) introduced a model of job search and optimal working hours and search time.

are necessary for the estimation of the model parameters by maximum likelihood.

2.1 Optimal strategy

Individuals maximize the expected present value of utility, subject to a budget constraint, while incorporating expectations about future job offers and layoffs. Utility in period t is specified by a utility function that is defined over net weekly income y_t and weekly working hours h_t. The utility function may include random preferences, which are denoted by ϵ. Period t utility is denoted by

$$u(y_t, h_t; \epsilon) \text{ with } \frac{\partial u(y_t, h_t; \epsilon)}{\partial y_t} > 0 \tag{2.1}$$

The budget constraint is linear. For someone employed it defines weekly income as the sum of labour income and non-labour income μ: $y_t = w_t h_t + \mu_t$. For someone unemployed income consists of weekly benefits b_t and (weekly) nonlabour income: $y_t = b_t + \mu_t$.

Job offers for unemployed individuals arrive according to a Poisson process with parameter λ. This arrival rate may depend on unobserved random variation, denoted by v. Accordingly, we denote $\lambda = \lambda(v)$. Furthermore, let q be a two-dimensional vector which contains both sources of random variation, i.e. random preferences ϵ and unobserved heterogeneity in the arrival rate v: $q = (\epsilon, v)'$.

For employed individuals there is an exogenous lay-off rate σ.

A job offer, as it is offered by an employer to an unemployed job searcher, consists of an hourly wage rate w_t, and a weekly amount if working hours h_t. A job offer is assumed to arrive randomly from a joint wage-hours offer distribution, denoted by $f(w, h)$:

$$f(w,h) = f(w)p_l, 0 < w < \infty, h = h_l, l = 1, ..., L \tag{2.2}$$

In (2.2) hours offers are modelled with a discrete distribution function: $p(h = h_l) = p_l$.

It is straightforward to show[7] that the individual's optimal acceptance strategy is characterized by a reservation utility level $\bar{u}(q)$:

$$\bar{u}(q) = u(b + \mu, 0; \epsilon) + \frac{\lambda(v)}{\rho + \sigma} \sum_{l=1}^{L} p_l \int_{\xi(h_l, \bar{u}(q); \epsilon)}^{\infty} [u(wh_l + \mu, h_l; \epsilon) - \bar{u}(q)] f(w) dw \tag{2.3}$$

[7] See e.g. Bloemen (1994). Equation (2.3) is a direct extension of the reservation wage equation in standard job search models (see e.g. Mortensen (1986)).

In (2.3) $\xi(h_l, \bar{u}(q); \epsilon)$ represents the hours dependent reservation wage: jobs with hours h_l and a wage rate exceeding $\xi(h_l, \bar{u}(q); \epsilon)$ are acceptable to the individual. For a given utility level $\bar{u}(q)$ the reservation wage is lower the closer is the hours level h_l to optimal hours.[8] Thus, individuals will only accept jobs with unfavourable working hours if they are compensated sufficiently in terms of the wage. The second term at the right hand side of (2.3) represents the expected gains from search. Note that individuals whose optimal hours have a high offer probability (for a given value of the job offer probability) will have higher gains of search and consequently will more often reject an offer and continue searching than individuals whose optimal hours have a low probability of being offered.

The resulting expression for the escape rate out of unemployment is

$$\theta(q) = \lambda(v) \sum_{l=1}^{L} p_l \bar{F}(\xi_l(q)) \tag{2.4}$$

in which $\bar{F}(.) = 1 - F(.)$ is one minus the distribution function of offered wages, and $\xi_l(q) := \xi(h_l, \bar{u}(q); \epsilon)$.

2.2 Specification

We specify the utility function according to Hausman (1980):

$$u(y, h; \epsilon) = -\ln(\gamma - \beta h) - \frac{\beta(h - X\delta - \epsilon - \beta y)}{\gamma - \beta h}, \beta < 0, \gamma > 0 \tag{2.5}$$

where X is a vector of observed individual characteristics. Utility function (2.5), combined with a linear budget constraint, implies a labour supply function that is linear in the wage rate and in non-labour income:

$$h^*(w, \mu) = \mu\beta + w\gamma + X\delta + \epsilon \tag{2.6}$$

The choice of utility function (2.5) is made partly because it has been applied widely within the literature of labour supply but also for reasons of tractability. For example, in combination with the specification of the wage offer distribution below, the gains of

[8] Here optimal hours is the level of hours for which the marginal rate of substitution between hours and income is equal to the reservation wage rate.

search in (2.3) can be solved analytically, which is desirable for reasons of computational fessibility. Moreover, the existence of an explicit solution for the labour supply function (2.6) makes it possible to easily combine subjective data on desired hours with the optimal hours generated by the model. Even smal1 generalizations of the labour supply function may complicate the analysis considerably since for solving the reservation utility leve1 we need the direct utility function. Bloemen and Kapteyn (1999), in the context of a static neo-classica1 labour supply model with taxes, use a labour supply function that is quadratic in the wage rate, and show how it complicates the analysis because of the need to impose coherency restrictions on preference parameters and the wage distribution.

Wage rates arive from a log-normal wage offer distribution with log-variante τ and log-mean $\zeta' x$. We allow for a log-normally distributed measurement error in the observed wage. Thus, we allow for a difference between between the latent accepted wage offer w and the observed wage w_{obs}.

The hours are categorized in 21 classes of four hours, with hours ranging from 1 to 84. The job offer arrival rate is parameterized as $\lambda(v) = \exp(\kappa_u' z_u + v)$ and the layoff rate as $\sigma = \exp(\kappa_e' z_e)$.

Unobserved heterogeneity q follows a bivariate normal distribution. We denote its density function by $g(q, \Sigma)$. Σ represents the covariance matrix and contains the variance σ_ϵ^2 of random preferences ϵ, the variance σ_λ^2 of the random term v in the job offer arrival rate and the covariance between the two $\sigma_{\epsilon v}$.

For specifying the relation between subjective information on desired hours $\tilde{h}$ and optimal hours generated by the model we will employ various specifications as will be discussed in the empirical part of the paper. For the moment we keep notation genera1 and denote its conditional density by $r(\tilde{h}|w, q)$. Thus, in genera1 we allow desired hours to depend on the accepted wage w.

2.3 Likelihood contributions

In the estimation of the model parameters we use both information on unemployed and on employed individuals. For the unemployed we observe information on unemployment duration t_u. For part of those with a transition into employment accepted wages and hours are observed as well. Information on job tenure t_e of employed individuals is used to estimate the layoff rate, and we also use information on observed wages and hours. Detailed information about the available data is given in the data descriptive section. In this section we discuss the likelihood contributions for the different types of observations. We will provide likelihood contributions for observations with complete durations sampled according to a flow sample scheme. The extension to right hand censored observations is straightforward. The likelihood contributions for a stock sample scheme can be obtained by conditioning on backward recurrence times. See Ridder (1984) for an extensive discussion of the latter.

Under the assumptions given, unemployment duration, conditional on unobserved heterogeneity q is exponentially distributed with parameter $\theta(q)$, given in (2.4). After integrating over unobserved heterogeneity the likelihood contribution of an unemployed whose after spell job characteristics are not observed becomes

$$f_u(t_u) = \int_{-\infty}^{\infty} \theta(q) \exp\{-\theta(q)t_u\} g(q,\Sigma)dq,\ 0 < t_u < \infty \tag{2.7}$$

The joint density of observed wages, observed hours, and desired hours (conditional on unobserved heterogeneity) can be derived in three steps. First, the distribution of accepted wages and hours follows from the offer distribution and the condition that accepted wages exceed the (hours dependent) reservation wage $(w > \xi_l(q))$. Next, the joint density function of the observed wage, the accepted wage, observed hours, and desired hours is obtained as the product of the density of the observed wage conditional on the accepted wage, the joint density of accepted wages and hours, and the density of desired hours. Finally, the latent accepted wage is integrated out by integrating over the range of wages that exceed the reservation wage. Appendix A contains the details of this procedure. It shows that for unemployed individuals whose after unemployment spell job characteristics are observed the likelihood contribution can be written as:

$$\begin{aligned} &f(t_u, w_{\text{obs}}, h_l, \tilde{h}) = \\ &\int \lambda(q) p_l \exp\{-\theta(q)t_u\} \int_{\xi_l(q)}^{\infty} f_{\text{obs,c}}(w_{\text{obs}}|w) f(w) r(\tilde{h}|w,q) dw g(q,\Sigma) dq \end{aligned} \tag{2.8}$$

In (2.8) w_{obs} represents the observed wage and w the latent accepted wage offer, while $f_{\text{obs,c}}(w_{\text{obs}}|w)$ follows from the density of measurement error in wage rates. Note that the likelihood contribution in (2.8) it to some extent comparable to that in a competing risk model: individuals can exit unemployment into L different states with different hours levels. Exit to state 1 occurs with probability $\lambda(v)p_l\bar{F}(\xi_l(q))$.[9] For employed individuals whose wages, hours and desired hours are observed the likelihood contribution can be obtained by integrating (2.8) over unemployment duration.

For individuals with no observation on desired hours or model specifications that do not include desired hours, the notation in (2.8) can be simplified by dropping $r(\tilde{h}|w,q)$ from (2.8).[10]

The job tenure of employed individuals is exponentially distributed with the layoff rate σ as a parameter. The likelihood contribution due to job tenure is straightforward and needs no further explanation.

In this particular application, the dimension of integrating over unobserved heterogeneity in (2.7) or (2.8) is two, and numerical integration is required. Moreover, in model specifications in which the density function of desired hours $r(\tilde{h}|w,q)$ enters, numerical integration over w is required, according to (2.8). Computational cost is further increased by the need to numerically solve the reservation utility level, which appears in the integrand, from (2.3). For this reason, we will employ the by smooth simulated maximum likelihood method (SSML) (see, for instance, Börsch-Supan and Hajivassiliou (1993)). We use $R = 30$ replications to simulate the integrals.

3 The data

We use data from the Dutch Socio-Economie Panel (SEP), which is a household panel survey collected by Statistics Netherlands. The households were interviewed twice a year, in April and October. We use data from the October 1985 wave up to and including the April 1989 wave. Thus, the total observation period is three and a half years. In each survey wave individuals are asked to report their occupational status for every month in the past 6 months. Selected are male individuals,[11] younger than 65, who reported to be

[9] In the appendix it becomes clear that the latter factor cancels against the denominator in (A.3)
[10] This is equivalent to integrating out $\tilde{h}$.
[11] The entire survey contains approximately 5000 households, aimed to be representative for the Dutch population. Due to low participation rates of females in the Netherlands in the eighties, selecting

unemployed or employed in any month during the observation period. The sample partly has a stock character[12] and partly a flow character. For every individual the (complete or incomplete) unemployment or employment duration from the point of sampling has been determined and for the stock sample observations we add information on backward recurrence times.

Thus, we obtained 573 observations on unemployment duration, of which 297 are observed to end with a transition into employment. Figure 1 plots the Kaplan-Meier estimate of the data on unemployment duration. In the SEP, information on working hours is collected twice a year for individuals employed at the time of the survey. Information on income is collected only in the October wave. For 191 individuals we observe the after unemployment spel1 wage-hours pair. We use subjective data on desired working hours for individuals who are employed at the time of the survey. For 189 of the previously unemployed individuals we observe desired working hours.

We have 4747 observations on employment duration, which will be used in the estimation of the layoff rate. We observe 252 transitions into unemployment. Note that it is not the purpose of the present paper to give an extensive and exhaustive explanation of job duration and transitions for the employed. The main reason for adding the observations in job duration is the estimation of the layoff rate which appears in the expression for the reservation utility leve1 (2.3), which makes it possible to deviate from the standard job search model assumption that unemployed individuals base their evaluation of the gains of search on the view that once a job has been accepted, it will last forever.

For 3771 of the employed (not including the observations on the previously unemployed, that we have already mentioned before) we observe the wage-hours pair. For 3216 observations we observe the subjective information on desired working hours.

Table 1 shows the sample statistics. The upper panel contains combined information about individuals in the unemployment and the employment spel1 sample. Information on accepted wages and hours of both types of observation is used in the estimation of the model. The mean number of weekly working hours is 40.6. Survey respondents were

a sample of unemployed females typically results in a low number of observations.

[12] In the estimation, we adjust the likelihood contributions of duration for stock sample observations by conditioning on backward recurrence times.

asked whether they were satisfied with the working hours in their present job or whether they preferred to work longer or shorter and if they reported to prefer to work longer or shorter they were asked for their desired number of working hours in their present *job.* Given the phrasing of the question, we assume that the answers of the survey respondents are conditional on remaining job characteristics, including the hourly wage rate. The model specifications for desired hours will allow for measurement error in desired hours.

The mean number of desired working hours is 39.0, which is slightly lower than the actual number of working hours. Among the individuals whose actual and desired working hours are both observed, 68.6% is satisfied with the number of hours worked at the present job; 25.3% reports to be overemployed and 6.1% would like to work more.

The average age is about 36 and the mean family size is 3.2. We distinguish four levels of education where leve1 1 is the lowest and leve1 4 the highest. We have divided the Netherlands into four regions. Region 1 is the most strongly industrialized part of the Netherlands which includes the larger cities. Region 4 is the least industrialized part of the Netherlands with a relatively low population density and a sizeable agricultural sector. Region 3 is the south of the Netherlands which contains some large companies and agricultural industry. In region 2 (the east) there is a mix of industry and agriculture. Apart from having information about the leve1 of education we have information available about the type or sector of education. Sector 1 is the technical sector which includes chemistry, physics, mathematics and biology, sector 2 includes the economic and administrative directions, sector 3 is genera1 education and sector 4 includes services.

The mean unemployment duration in the sample of 573 unemployment spells is 14 months, whereas the median (not shown in the table) is 6 months. The average age of the individuals in the sample with unemployment spells is about 34, whereas the mean family size is 2.9.

The mean employment duration in the sample of 4747 employment spells is 87.5, about 7 years, whereas the median employment duration (not shown in the table) is 3 years.

4 Results

In this section we discuss the estimates of two versions of the model. The first version is considered as the base: the base version is the model outlined in section 2, but in the estimation no use is made of information on desired hours. In the second variant we use information on desired hours in the estimation of the model. The structure of the economic model though remains the same: *observed* hours are modelled as the realization of an accepted wagehours offer. We denote the reported desired number of working hours by $\tilde{h}$. Desired working hours are linked to optimal working hours h^*, defined in (2.6), by

$$\ln \tilde{h} = \ln h^* + \nu, \nu \sim N(0, \sigma_\nu^2) \tag{4.1}$$

In (4.1) ν represents a normally distributed measurement error. Thus, (4.1) establishes a close link between the observed desired hours and the neo-classical optimal working hours. In section 5 we present, by way of sensitivity analysis, an alternative model specification in which we also use the information on desired working hours, but in which the link with the concept of neo-classica1 working hours is much weaker: instead of modeling desired hours as a direct observation of neo-classica1 working hours, we assume that for indiviuals who report to be satisfied with their working hours the observed hours are 'close to' optimal hours.

4.1 Parameter estimates

The parameter estimates of the first two variants are presented in the first two main columns of table 2. Table 2a shows the estimates of the utility parameters. As is typical in the labour supply literature, we included information related to household composition: the household family size and the marital status of the respondent appear as covariates in the utility function. Job search models without working hours usually only contain the arrival rate and the wage offer distribution, so information on household characteristics is usually not included. The identification in the base model of structural parameters of the utility function like β and γ is achieved because they measure the impact of income on the unemployment duration by their impact on the reservation wage and the acceptance probability. Note that for the identification of the parameters of the household characteristics in the utility function the exclusion restriction that household characteristics only enter utility plays an important role. We include age dummies in both the utility function and the arrival rate. As a consequence, in the base model information on unemployment duration is used to identify both the effect of age on preferences and the influence of age on the arrival rate, and it is clear that here identification of the age effects leans on the imposed structure and functional form. Once we include information on desired hours, separate identification of the effects of age on utility and on the arrival rate is possible.

Note that the parameters β and γ are larger in the base model. By (2.6), this implies larger effects of non-labour income and the wage rate on optimal working hours compared to the estimates obtained with desired hours. In both model variants, there is a significant impact of family size on preferences: a larger family size is aasociated with stronger preferences in favour of working. The same holds for marital status: married men like to work more hours. The effects of family size and marital status are smaller if information on desired hours is included in the estimation of the model. The two model variants show different age patterns. The variant with desired hours shows that optimal hours decrease monotonically with age, whereas there is an inverted U-shaped pattern for the base variant. Apart from the difference in the age pattern, there is also a difference in the magnitude of the age effects: for the groups aged between 25 and 45, the model with desired hours shows a smaller effect of age. The estimated variance of the random preferences is much lower in the model variant with desired hours than in the base variant.

Table 2b shows the parameter estimates of the job offer arrival rate. The base model shows a U-shaped impact of age on the arrival rate. The model with desired hours shows that only the youngest age group has a significant larger arrival rate. The discussion on identification above showed that identification of the base model is achieved by functional form: in the base model the larger impact of age on preferences in favour of working for the middle two age groups apparently has to be compensated by a smaller impact of age for these groups on the job offer arrival rate, compared to the model with desired hours, in order to obtain a comparable impact on unemployment duration. Both model variants show positive and significant education dummies, possibly due to more complicated and lengthy application and hiring procedures for the higher educated. For the sectoral dummies the models yield similar results. Both models assign the highest arrival rates to individuals with a technical and an economic/administrative type of education, although the base model assigns the highest job offer arrival rate to the economic/administrative sector, whereas the model with desired hours assigns the highest arrival rate to the technical sector. Finally, the variance of the unobserved heterogeneity in the arrival rate is higher in the base model than in the model with desired hours. Note that the estimate in the model with desired hours is not significant.[13]

Table 2c shows the parameter estimates of the lay-off rate. The differences between the two models are not very large. Both models imply that the layoff rate is decreasing with age, and that individuals with the two lowest levels of education have the highest layoff rate. Individuals in the service sector have the highest layoff rate. Region does not affect the layoff rate. The largest differences are found for education: the model estimated with information on desired hours shows that workers with one of the lower two education levels have a significantly higher layoff rate, which is plausible. For the base model, the effect for these education levels is positive but not significant.

The parameter estimates of the wage offer distribution in table 2d show that offered wages increase with the level of education and show an inverted U-shaped pattern in age (with peaks at the age of 44 and 49). For both model variants, the offered wages are lowest for individuals with a technical and economic type of education. The variance of the wage offer distribution is of comparable magnitude, whereas the variance of the distribution of measurement error is higher for the model with desired hours.

Finally, table 2e shows the parameter estimates of the hours offer distribution. Note that some restrictions on the probabilities of certain hours categories have been placed due to low numbers of observations in certain cells. Both model variants show the peak

[13] We experimented with imposing correlation between the random preferences ϵ and the unobserved heterogeneity v. In the base model, the correlation was insignificant. In the model with desired hours, it was hard to identify the parameter, which is understandable once we see the small and insignificant variance in table 2b that is obtained if we do not impose correlation.

of the distribution of working hours at 40 hours a week. Moreover, the base model assigns higher offer probabilities to weekly numbers of working hours below 40, whereas the model with desired hours assigns higher offer probabilities to working hours above 40. As we will see later on, this is accompanied by a reversed pattern in optimal hours: the base model simulates higher frequencies of desired hours above 40 than the model with desired hours.

4.2 Benefit elasticities and reservation wages

To compare the implications of the models we computed the benefit elasticity of the hazard for a given set of individual characteristics. For benefits, the non-labour income, the family size and the age of the individual we took the sample means for the unemployed from table 1. For the leve1 of education, the sector of education, the region and marital status we took the lowest leve1 of education, no specialization, the western region, and married. We averaged over 13000 replications from the distribution of unobserved heterogeneity.

To see how reservation wage rates vary with hours, we computed the reservation wages for every hour category for the given type of individual. Again, we averaged over unobserved heterogeneity. Recall from section 2 that due to variation in preferences with respect to working hours the reservation wage *rate* is a function of working hours that reaches a minimum in optimal hours. Note that if preferences would not depend on working hours, reservation income is constant and the reservation wage *rate* monotonically decreases with hours, the latter because working e.g. twice as many hours requires the wage rate to be twice as low to keep labour income constant.

Table 3 shows the elasticities and the reservation wage rates. The elasticity that measures the impact of the benefit leve1 on the exit rate out of unemployment is -0.35 for both models. Table 3 also shows the reservation wage rate as a function of hours. Note that the reservation wage as a function of hours is much flatter for the base model than for the model with desired hours: for the base model, there is not much variation in the reservation wage for working weeks of 40 hours or higher implying that preferences are not very sensitive with respect to these hours levels. For the base model, the minimum reservation wage is reached for hours levels of 48 to 60, implying that this is the optimal number of working hours for an individual of the given type. This would suggest that there is underemployment. The model with desired hours reaches its minimum at 36 to 40 hours a week. Note that for this model, reservation wages are lowest in the range of 32 to 52 hours a week.

Figure 2 plots reservation wage rates as a function of hours in the range of 16 to 84. The graph contains the reservation wage rates for the base model as well as for the model estimated with desired hours. For reasons of comparison, we also plotted the wage rates that correspond with a constant reservation income.[14] It is clear that the reservation wage rates of the base model show a pattern that is closer to the constant reservation income case than does the model estimated with desired hours.

Table 3 also shows the elasticities of the reservation wage rates with respect to the benefit level. It shows slightly larger elasticities for the base model than for the desired hours model. E.g. at 40 hours a week the elasticity of the reservation wage with respect to the benefit level is 0.08 for the base model and 0.06 for the desired hours model, whereas the values are not in each others 95% confidence interval.

4.3 Residual analysis

To analyse the fit of the model we plotted the residuals. Note that both models are stationary structural duration models, so the models do not account for possible duration dependence of the hazard. The models though do incorporate various sources of unobserved heterogeneity. The residuals of both models are plotted in figure 3. The straight line in the figure is the survivor function according to an exponential distribution with parameter 1. If the models are correctly specified, the residuals should be distributed according to this distribution. Although it is clear that the models would not survive a formal test, the results are not that bad for stationary structural duration models. The models do ressonably well for shorter durations but fail to explain some of the larger durations. The residuals reveal evidence of neglected negative duration dependence of

[14] The value of the constant reservation income is equal to the reservation income of the base model at 40 hours a week. The plot of the constant reservation income wage rates at this particular value is shown only for reason of exposition.

the hazard. The fit of the base model is comparable to the model estimated with desired hours, even though the use of additional data on desired hours imposes additional restrictions on the parameters of the utility function.

4.4 The distribution of working hours

For the different model specifications the distribution of working hours has been simulated. For every individual with observed working hours in the sample we computed the distribution of working hours, implied by the model, conditional on unobserved heterogeneity q, for 30 replications of q, and we averaged over these 30 replications and individuals to obtain the simulated hours frequencies. We also simulated the optimal number of working hours, implied by the labour supply function (2.6) by computing the optimal number of working hours for every individual in the sample with observed desired working hours and for 30 replications of random preferences. The results of the simulations are shown in tables 4 and 5. The observed working hours show a peak of 67% around a working week of 40 hours a week. The simulated hours distributions of both models approximate the empirical distribution of observed hours closely. Given the flexible specification of the hours offer distribution this is no surprise. Adding the information on desired hours teaches us more about the underlying preference structure with respect to working hours. The frequencies of optimal hours according to the base model are flat. The base model does succeed to assign low frequencies to low weekly numbers of working hours, although the frequencies are higher than for the distribution of observed desired working hours. The base model fails to track the location of desired working hours and also assigns too much probability mass to numbers of weekly working hours that exceed 40. The model estimated with desired hours does better in the sense that the model places most of the probability mass of desired working hours in the area or 32 to 44 hours a week. The attempt to fit the high peaked data led to less probability mass assigned to high numbers of optimal working hours, compared to the distribution of observed desired working hours. The model does not succeed to predict the peak and the asymmetry in desired working hours. However, the model with desired hours succeeds in predicting that there are more overemployed than underemployed individuals.

5 Sensitivity analysis

In the previous section we presented the estimation results of two different model specifications. In the first variant no use has been made of subjective information on working hours, whereas in the second variant the subjective information was, apart from a measurement error, interpreted as the outcome of the neo-classica1 labour supply function. This way of interpreting subjective information on desired hours is common practice in the literature. Table 5, though, shows that there is still a difference in the distribution of optimal hours generated by the second variant and the empirical distribution of desired hours. The empirical distribution of desired hours shows a peak at working weeks of 40 hours, although it is much smaller than the peak in the distribution of observed hours, and it is hard to explain this peak by optimal working hours generated by the neo-classica1 labour supply function.

In this section we discuss two alternative model specifications that may succeed better in explaining the peak in the empirical distribution of desired working hours. We have estimated one of these two alternatives. By doing so we deviate from the common practice in the literature on the estimation of labour supply models with desired hours, in which the shape of the empirical distribution of desired hours usually is ignored. We stress, however, that apart from trying to improve upon the fit of the distribution of desired hours, one of the main roles of the alternative specification is to perform a sensitivity analysis on the estimation results presented in the previous section.

The first specification is the *interpretation* error variant. An economist may be tempted to interpret subjective information on working hours as the outcome of the neo-classica1 labour supply model, i.e. the outcome of a choice process without offer restrictions. A survey respondent who is asked for the satisfaction with current working hours may, however, very well condition his answer implicitly on hours restrictions. If, for example, he works 40 hours a week and would like to work 32 hours a week, but knows that there are very few jobs offered with 32 hours a week whereas many of the available jobs require working 40 hours a week, he may answer that he is satisfied with the current number of working hours. If however, his preference for working 32 hours a week is strong enough, even though the offer probability is small, he may answer that he would like to work 32 hours a week. According to this idea, desired hours may be much more similar to *expected* hours instead of optimal hours. According to the model outlined in section 2, expected hours (conditional on unobserved heterogeneity q) are equal to

$$Eh = \sum_{l=1}^{L} \alpha_l h_l \text{ with } \alpha_l = \frac{\bar{F}(\xi_l(q))p_l}{\sum_{j=1}^{L} \bar{F}(\xi_j(q))p_j} \tag{5.1}$$

Thus, expected hours is a weighted average of working hours. Hours get a high weight in determining this weighted average either if they have a high offer probability p_l or if they have a high acceptance probability $\bar{F}(\xi_l(q))$. Note that the acceptance probability is highest for working hours with the lowest reservation wage rate, i.e. optimal hours. Individuals with stronger preferences for a given amount of working hours will have a more pronounced pattern between reservation wage rates and working hours. Data on desired hours may be linked to the expected hours in (5.1) by assuming a log-normally distributed messurement error between the two. There is an important caveat to this specification: it assumes that the mean desired hours are equal to the mean observed hours. Thus, the specification cannot explain the existence of e.g. overemployment. For this reason, we decided not to estimate this variant.

The second variant of our sensitivity analysis is the measurement error variant. In this variant the difference in the distribution of optimal hours generated by the model and the empirical distribution of desired hours is attributed to measurement error. The log-normally distributed measurement error specification employed in the previous section is apparently not able to bridge the gap between the peak in the distribution of observed desired hours and the more regular pattern in the distribution of simulated desired hours (see table 5). We assume here that if the observed hours h of a respondent are 'close to' (but not necessarily equal to) optimal hours h^* the respondent will answer that he is satisfied with his current amount of working hours. If the difference between observed hours and optimal hours is 'large' he will answer not to be satisfied with current working hours and will subsequently report the amount of desired working hours $\tilde{h}$. The idea behind this specification is that 'satisfaction' with current working hours is not necessarily the same as 'optimality'. Thus, the specification for desired hours will be

$$\begin{aligned} \tilde{h} &= h \quad \text{if} \quad |h - h^*| \leq c \\ \tilde{h} &= h^* \exp(\nu) \quad \text{if} \quad |h - h^*| > c \\ & c = \bar{c} + \omega, \omega \sim N(0, \sigma^2_\omega) \end{aligned} \tag{5.2}$$

In (5.2) $\bar{c}$ is a parameter (constant across individuals) to be estimated. It is identified by the fact that we have both observations on individuals who are satisfied with their current working hours and on individuals who want to work more or less. For individuals who are satisfied with their current working hours the likelihood contribution will be the probability that observed and optimal working hours are within a distance c from each other, whereas for under- or overemployed the likelihood contribution is equal to the probability of under- or over employment and the density of the desired number of working hours. In (5.2) we assume that ω and ν are uncorrelated. Note that correlation between the condition $|h - h^*| > c$ for under- or overemployment and desired hours $\tilde{h}$ runs through random preferences ϵ by its influence on optimal hours h^*. The attractiveness of this specification is that it explicitly incorporates the structure of the questionnaire.

Note that both of the alternatives that we discussed have one thing in common: they loosen the link between the information on desired hours and the concept of the neo-classica1 optimal hours. Thus, we may consider the two specifications estimated in the previous section as two extremes: one (the base) without any information on desired hours and one with a strong link between desired hours and optimal hours. In this section we add the estimation results of the *measurement* error variant, and it is interesting to see whether the outcome results in a flat relationship between reservation wage rates and hours, like the base model, or whether the information on desired hours stil1 adds to the identification of preferences for working hours.

The parameter estimates can be found in the third main column of table 2. We will not discuss the results in detail, but it is clear that overall the estimates look much more similar to the results obtained with the (neo-classical) desired hours model than to the base model.

If we look at the estimates $\bar{c}$ and σ_ω that are specific to this variant according to (5.2) we see that the esimate of the gap $\bar{c}$ is 16.3 and its standard deviation σ_ω is 12.9. Thus, the estimated gap and its standard error are quite large which means that unobserved factors play a large role in explaining whether or not someone reports to be satisfied with working hours. This indicates that either the measurement error hypothesis in (5.2) is an unlikely explanation for the respondent's reporting behaviour or that more flexible specifications are necessary. For the latter purpose, we may think of a gap that may be asymmetric, or a gap that may depend on actual working hours and the size of the offer probability of these hours, thereby bringing in elements from the *interpretation* error model.

Figure 2 gives us insight in the sensitivity of the relation between reservation wage rates and working hours for the alternative way of modelling desired hours. It shows that the reservation wage rate has a clear minimum at 36 to 40 hours a week, and therefore we may conclude that this variant that weakens the relation between optimal hours and desired hours stil1 teaches us something about the preferences for working hours.

A difference with the neo-classica1 desired hours is that for the measurement error model reservation wages are lower for small numbers of working hours, so the model predicts that individuals are less averse to working smaller hours than does the neo-classica1 desired hours model. An explanation for this is that by (5.2) low (as well as high) numbers of desired hours may have a larger impact in determining the parameters of optimal working hours.

Another difference is the sensitivity of reservation wages and the hazard out of unemployment with respect to the benefit level: table 3 shows larger elasticities.

Table 5 shows that by the specification in (5.2) we manage to predict a sizeable peak in the distribution of desired hours at 40 hours a week. The peak, though, is smaller than the peak in observed desired hours, and overall the pattern in the simulated desired hours is somewhat flatter than the pattern in the observed desired hours. Nevertheless, compared to the simulated desired hours of the second variant in section 4, in which, by (4.1), the only difference between optimal hours and desired hours is a lognormally distributed measurement error, it is a big improvement.

By way of summary we may say that the results of the measurement error show that we are stil1 able to draw conclusions with respect to preferences for working hours even though in this model the link between data on desired hours and the optimal hours is much weaker. The model gives a better fit of the data in desired hours. We also see a larger sensitivity of the hazard out of unemployment with respect to the benefit leve1 and a smaller aversion to working low numbers of hours.

6 Conclusions

The failure of the neo-classica1 model of labour supply to explain the observed pattern in working hours has led to the development of labour supply models with hours restrictions. The availability of jobs in this class of models is limited and subject to a job offer probability. Identification is problematic as observed hours are the outcome of an interaction between offered hours, determined by the demand side of the labour market, and preferences which determine the acceptance of a job. Subjective data on desired hours, together with data on actual working hours, can serve as a source of information to identify the preference parameters in the model.

According to these lines of thoughts, we specify a job search model, in which a job offer is modeled as a random arrival from a joint wage-hours offer distribution and in which individuals base their job acceptance decisions on the utility leve1 of the job offer. The job acceptance decision can be characterized by a reservation utility level, which can be transformed to an hours-dependent reservation wage rate.

We specify and estimate a structural job search model for unemployment duration, accepted wages and hours, and desired hours, using data for the Netherlands from the Dutch socio-economie panel. The model allows for unobserved heterogeneity in preferences and in the job offer arrival rate. We estimate the parameters of the utility function, and thereby optimal working hours, job offer arrival rates, layoff rates and the wage and hours offer distribution.

We estimated three model specifications which differ in the extent in which data on desired hours are imposed on the model: the base does not use the information at all, the neo-classica1 variant imposes a strong link between data on desired hours and optimal hours and in the measurement error model the link between desired hours and optimal hours is weakened. The latter specification assumes that for individuals who report to be satisfied with their actual working hours the distance between actual hours and optimal hours is ‘small’. For respondents who report not to be satisfied with actual working hours the reported number of desired hours is treated as an observed value of optimal hours.

All of the three specifications fit the data on unemployment duration about equally well according to residual analysis. The residual analysis also reveals neglected negative duration dependence for the models. Especially the longer spells of unemployment cannot be explained by a stationary model, even if unobserved heterogeneity is accounted for.

The reservation wage rates are somewhat more sensitive with respect to the benefit leve1 according to the base model compared to the neo-classica1 model variant with desired hours. The messurement error model generates the largest elasticities of the reservation wage rate with respect to the benefit level. Estimates of the elssticity of the exit rate with respect to the benefit leve1 do not differ between the base and the neo-classical variant with desired hours, but the elasticity is larger for the measurment error model.

The models show different results for individual preferences for working hours. The base specification suggests that preferences are relatively flat: this is shown by the shape of the distribution of optimal hours generated by the model as well as by the shape of the reservation wage rate as a function of hours, which does not have a pronounced minimum. The variant in which desired hours are linked to the labour supply function shows a concentration of optimal hours in the range of 32 to 44 hours a week and a pronounced minimum of the reservation wage rate at 36 hours a week. The messurement error model stil1 generates a clear relationship between reservation wage rates and working hours, even though the link between desired hours and optimal hours is much weaker in this variant. The model shows smaller reservation wage rates at low working hours than the previous two specifications

The base model fails to predict that the location of optimal hours is below that of observed hours, as suggested by the information on desired hours. Moreover, the base model assigns smaller offer probabilities to working weeks above 40 hours in combination with a smaller aversion to accepting these hours compared to the model variants with desired hours. Thus, the base model places more emphasis on smal1 offer probabilities as a reason for observing low sample frequencies of observed hours above 40, whereas the model variants with desired hours place more emphasis on the unwillingness of individuals to accept jobs with working weeks above 40 hours.

For the messurement error model we estimated that the average value of the distance between optimal hours and observed hours below which the respondent will report to be satisfied with working hours is 16, which is quite large and does not add to the plausibility of the model as an explanation for observing a peak in the empirical distribution of desired hours. Its standard deviation is estimated to be 13. However, the model does provide a better fit of desired hours, and does a good job in showing that even after weakening the link between desired and optimal hours, data on desired hours stil1 provide information about the relation between hours and reservation wage rates.

Table 1 Sample **statistics**

Entire sample n = 5320		
variable	mean	standard deviation
Observed working hours (hours/week, n = 3962)	40.6	8.7
net earnings (guilders/week, n = 3962)	535.3	300.2
Desired hours (hours/week, n = 3405)	39.0	8.1
Difference observed-desired hours (n = 3404)	1.7	6.8
non-labour income (guilders/week)	28.9	94.6
non-labour income (guilders/week, pos. val. only, n = 2087)	73.6	193.8
age	35.9	11.3
family size (persons)	3.2	1.4
Diff. observed-desired hours >0	25.3%	
Diff. observed-desired hours =0	68.6%	
Diff. observed-desired hours <0	6.1%	
education level	mode 3	
Dutch nationality	98.1%	
region 1 (industrialized west)	42.2%	
region 2 (east)	24.0%	
region 3 (south)	23.2%	
region 4 (agricultural)	10.6%	
sector of education 1 (technical)	41.3%	
sector of education 2 (economic/administrative)	15.6%	
sector of education 3 (no specialization)	29.0%	
sector of education 4 (services)	14.1%	
Unemployment spells n = 573		
variable	mean	standard deviation
benefits (guilders/week)	162.8	166.4
benefits (guilders/week, pos. val. only, n = 317)	294.3	106.3
non-labour income (guilders/week)	20.0	53.7
non-labour income (guilders/week, pos. val. only, n = 163)	70.1	81.4
unemployment duration (months)	14.2	15.8
age	34.2	11.7
family size (persons)	2.9	1.4
education level	mode 2	
Dutch nationality	95.6%	
married	50.4%	
region 1 (industrialized west)	30.9%	
region 2 (east)	31.4%	
region 3 (south)	24.8%	
region 4 (agricultural)	12.9%	
sector of education 1 (technical)	37.5%	
sector of education 2 (economic/administrative)	10.3%	
sector of education 3 (no specialization)	39.6%	
sector of education 4 (services)	12.6%	

Employment spells n = 4747 (table 1, continued)		
variable	mean	standard deviation
non-labour income (guilders/week)	30.0	98.4
non-labour income (guilders/week, pos. val. only, n = 1924)	73.9	143.6
employment duration	87.5	109.2
age	36.1	11.2
family size (persons)	3.3	1.3
education level	mode 3	
Dutch nationality	98.4%	
region 1 (industrialized west)	43.6%	
region 2 (east)	23.1%	
region 3 (south)	23.0%	
region 4 (agricultural)	10.3%	
sector of education 1 (technical)	41.8%	
sector of education 2 (economic/administrative)	16.2%	
sector of education 3 (no specialization)	27.7%	
sector of education 4 (services)	14.3%	

Table 2a: Parameters of the utility function

Variable	The base model		Estimates with desired hours		Measurement error model	
	Estimate	se	Estimate	se	Estimate	se
4	-0.044**	0.002	-0.023**	0.001	-0.042**	0.001
γ	0.79**	0.05	0.63**	0.03	0.52**	0.02
δ_1 Intercept	31.6**	1.2	24.7**	0.5	24.4**	0.5
δ_2 Family size	4.6**	0.7	2.7**	0.3	2.4**	0.3
δ_3 Married	3.5**	0.8	2.5**	0.3	2.6**	0.4
δ_4 Age ≤ 25	0.8	1.2	4.5**	0.4	7.0"	0.6
δ_5 $25 < \text{Age} \leq 35$	4.4**	1.0	2.5**	0.3	3.1**	0.3
δ_6 $35 < \text{Age} \leq 45$	4.3"	1.2	1.4**	0.4	2.2**	0.5
σ_ϵ	13.9**	0.3	8.3**	0.1	9.8**	0.1
σ_ν (Sd measurement error desired hours)			0.20**	0.00	0.14**	0.001
$\bar{c}$					16.3**	0.6
σ_ω					12.9**	0.6

** indicates significance at 5% level
* indicates significance at 10% level

Table 2b: Parameters of the job offer arrival rate

Variable	The base model		Estimates with desired hours		Measurement error model	
	Estimate	se	Estimate	se	Estimate	se
Intercept	-1.16**	0.27	0.83	0.72	2.8**	0.6
Age $\leq$ 25	-0.24	0.16	0.54**	0.28	0.41*	0.24
25 $<$ Age $\leq$ 35	-0.29**	0.13	0.17	0.21	0.10	0.17
35 $<$ Age $\leq$ 45	-0.17*	0.10	0.05	0.17	0.05	0.14
Educl	7.8**	1.0	5.3**	1.3	6.2**	1.6
Educ2	4.6**	0.4	3.2**	0.6	4.3**	0.8
Educ3	4.6**	0.2	3.9**	0.7	7.0**	0.7
Region 1 (ind. west)	0.17	0.11	0.30*	0.15	0.25**	0.12
Region 2 (east)	-0.20*	0.11	-0.18	0.17	-0.16	0.13
Region 3 (south)	-0.02	0.12	0.02	0.18	-0.01	0.14
Sector 1 (technical)	2.25**	0.36	8.7**	1.8	4.5**	0.8
Sector 2 (econ./adm.)	2.72**	0.38	4.0**	1.3	2.3**	0.9
Sector 3 (no special.)	-0.66**	0.22	-0.29	0.61	-0.78	0.55
σ_λ	0.26**	0.06	0.065	0.084	0.010	0.07

** indicates significance at 5% level
* indicates significance at 10% level

Table 2c: Parameters of the layoff rate						
Variable	The base model		Estimstes with desired hours		Measurement error model	
	Estimate	se	Estimate	se	Estimate	se
Intercept	-8.0**	0.3	-8.0**	0.3	-8.3**	0.1
Age ≤ 25	2.6**	0.2	2.5**	0.2	2.5**	0.1
25 < Age ≤ 35	1.4**	0.2	1.4**	0.2	1.5**	0.1
35 < Age ≤ 45	0.57**	0.23	0.64**	0.23	0.74**	0.22
Educl	0.08	0.24	0.54**	0.25	0.59**	0.11
Educ2	0.27	0.20	0.57**	0.21	0.56**	0.10
Educ3	-0.63**	0.21	-0.39*	0.21	-0.42**	0.10
Region 1 (ind. west)	-0.24	0.19	-0.22	0.19	0.004	0.12
Region 2 (east)	0.22	0.19	0.12	0.19	0.35**	0.09
Region 3 (south)	0.12	0.19	0.11	0.19	0.32*	0.17
Sector 1 (technical)	-0.43**	0.17	-0.58**	0.17	-0.55**	0.16
Sector 2 (econ./adm.)	-0.43*	0.23	-0.69**	0.24	-0.66**	0.23
Sector 3 (no special.)	-0.26	0.18	-0.61**	0.20	-0.65**	0.19

** indicates significance at 5% level
* indicates significance at 10% level1

Table 2d: Parameters of the wage offer distribution

Variable	The base model		Estimates with desired hours		Measurement error model	
	Estimate	se	Estimate	se	Estimate	se
Intercept	1.3**	0.1	0.83**	0.18	0.17	0.14
log(Age/16)	1.8**	0.1	1.6**	0.1	1.48**	0.10
$\{\log(Age/16)\}^2$	-0.9**	0.1	-0.8**	0.1	-0.69**	0.06
Educl	-1.61**	0.13	-0.98**	0.15	-1.24**	0.22
Educ2	-1.03**	0.06	-0.62**	0.07	-0.88**	0.11
Educ3	-0.99**	0.04	-0.65**	0.08	-1.17**	0.10
Sector 1 (technical)	-0.38**	0.06	-0.96**	0.19	-0.62**	0.10
Sector 2 (econ./adm.)	-0.39**	0.06	-0.43**	0.16	-0.28**	0.12
Sector 3 (no special.)	0.11**	0.04	0.04	0.09	0.12	0.09
τ	0.52**	0.01	0.48**	0.03	0.63**	0.02
σ_m	0.23**	0.004	0.31**	0.002	0.30**	0.002

** indicates significance at 5% level
* indicates significance at 10% level

Table Ze: Parameters of the hours offer distribution

	The base model		Estimates with desired hours		Measurement error model	
Hours	Estimate	Se	Estimate	se	Estimate	se
h_l =	$p_l = P(h = h_l)$		$p_l = P(h = h_l)$		$p_l = P(h = h_l)$	
4, 8, 12, 16	0.032**	0.006	0.032**	0.006	0.012**	0.002
20	0.067**	0.008	0.043**	0.005	0.025**	0.003
24	0.030**	0.004	0.016**	0.002	0.012**	0.002
28	0.019**	0.003	0.010**	0.002	0.0094”	0.0014
32	0.039**	0.004	0.022**	0.002	0.025**	0.002
36	0.034**	0.003	0.024**	0.002	0.027**	0.002
40	0.55**	0.02	0.47**	0.02	0.57**	0.01
44	0.047**	0.003	0.052”	0.004	0.062**	0.004
48	0.012**	0.001	0.018**	0.002	0.020**	0.002
52	0.031**	0.003	0.063**	0.005	0.068**	0.005
56	0.0083**	0.0012	0.024**	0.003	0.024”	0.003
60	0.014**	0.002	0.053**	0.006	0.050**	0.005
64, 68	0.0021**	0.0004	0.012**	0.002	0.0093**	0.0015
72	0.0055**	0.0010	0.048**	0.009	0.033**	0.005
76, 80, 84	0.0029**	0.0005	0.0028**	0.0002	0.0030**	0.0001

Note: $p_l = P(h = l \times 4)$ or,more precisely, $P(l - 2 \leq h < l + 2)$
** indicates significance at 5% level
* indicates significance at 10% level

Table 3: Reservation wages and elasticities

	Base model		Model des. hours		Mess. err. model	
Elasticity hazard/benefit	-0.35	(0.02)	-0.35	(0.05)	-0.50	(0.04)
Hours	Reserv. wage rate	Elast. res. wage rate wrt benefit	Reserv. wage rate	Elast. res. wage rate wrt benefit	Reserv. wage rate	Elast. res. wage rate wrt benefit
4	136.7	0.02	134.1	0.02	102.3	0.05
		(0.002)		(0.002)		(0.002)
8	61.3	0.03	57.7	0.03	44.7	0.07
		(0.003)		(0.002)		(0.003)
12	37.4	0.04	33.8	0.04	27.0	0.09
		(0.004)		(0.003)		(0.003)
16	26.2	0.05	23.0	0.05	19.2	0.11
		(0.004)		(0.004)		(0.004)
20	20.0	0.06	17.3	0.05	15.2	0.12
		(0.005)		(0.004)		(0.004)
24	16.2	0.06	14.1	0.06	13.0	0.13
		(0.005)		(0.004)		(0.004)
28	13.9	0.07	12.3	0.06	11.8	0.14
		(0.005)		(0.005)		(0.005)
32	12.3	0.07	11.3	0.06	11.2	0.14
		(0.006)		(0.005)		(0.005)
36	11.4	0.08	10.9	0.06	11.0	0.14
		(0.006)		(0.004)		(0.004)
40	10.7	0.08	10.8	0.06	11.0	0.14
		(0.006)		(0.004)		(0.004)
44	10.4	0.08	11.0	0.06	11.2	0.13
		(0.006)		(0.004)		(0.004)
48	10.2	0.08	11.3	0.05	11.5	0.13
		(0.006)		(0.004)		(0.004)
52	10.1	0.08	11.8	0.05	11.9	0.12
		(0.005)		(0.004)		(0.004)
56	10.2	0.08	12.4	0.05	12.3	0.11
		(0.005)		(0.003)		(0.003)
60	10.3	0.07	13.0	0.04	12.7	0.11
		(0.005)		(0.003)		(0.003)
64	10.5	0.07	13.7	0.04	13.2	0.10
		(0.005)		(0.003)		(0.003)
68	10.7	0.07	14.4	0.04	13.7	0.10
		(0.005)		(0.003)		(0.003)
72	11.0	0.07	15.1	0.04	14.3	0.09
		(0.005)		(0.003)		(0.003)
76	11.3	0.06	15.8	0.03	14.8	0.09
		(0.005)		(0.002)		(0.003)
80	11.6	0.06	16.6	0.03	15.3	0.09
		(0.004)		(0.002)		(0.003)
84	11.9	0.06	17.3	0.03	15.8	0.08
		(0.004)		(0.002)		(0.002)

Standard errors of elasticities in parentheses

Table 4: The distribution of observed and simulated observed hours

Hours Category h =	Observed hours frequencies	Simulated with base model	Simulated, model w. des. hours	Simulated with measurement error model
4	0.001	0.001	0.001	0.003
8	0.002	0.002	0.001	0.005
12	0.004	0.004	0.005	0.008
16	0.005	0.006	0.012	0.011
20	0.020	0.019	0.034	0.028
24	0.013	0.012	0.018	0.015
28	0.011	0.011	0.014	0.012
32	0.031	0.030	0.033	0.031
36	0.034	0.033	0.036	0.033
40	0.670	0.665	0.647	0.655
44	0.067	0.067	0.065	0.065
48	0.019	0.019	0.019	0.019
52	0.054	0.055	0.054	0.054
56	0.016	0.016	0.016	0.016
60	0.027	0.027	0.027	0.027
64	0.007	0.004	0.005	0.004
68	0.001	0.004	0.003	0.003
72	0.010	0.010	0.010	0.010
76	0.001	0.005	0.0004	0.001
80	0.005	0.005	0.0003	0.001
84	0.002	0.004	0.0002	0.0004

Note: Hours category with hours $= l: l \quad 2 \leq \quad < l + 2)$
l=4: lowerbound 0, l= 84: upperbound ∞

Table 5: The distribution of desired, optimal hours and simulated desired hours

Hours Category $h =$	(Observed) desired hours	Optimal acc. to base	Optimal, model w. des. hours	Optimal, measurement error model	Simulated, model w. des. hours	Simulated, measurement error model
4	0.001	0.008	0.003	0.011	0.003	0.011
8	0.002	0.006	0.005	0.013	0.007	0.012
12	0.002	0.011	0.014	0.028	0.020	0.025
16	0.004	0.019	0.034	0.051	0.045	0.041
20	0.023	0.030	0.064	0.082	0.078	0.062
24	0.017	0.044	0.103	0.117	0.113	0.065
28	0.010	0.058	0.143	0.144	0.134	0.064
32	0.112	0.077	0.165	0.154	0.139	0.066
36	0.117	0.090	0.160	0.140	0.124	0.057
40	0.548	0.101	0.129	0.111	0.104	0.415
44	0.055	0.106	0.088	0.073	0.077	0.060
48	0.017	0.104	0.051	0.042	0.055	0.026
52	0.047	0.092	0.024	0.021	0.037	0.043
56	0.012	0.078	0.010	0.009	0.024	0.016
60	0.017	0.060	0.004	0.003	0.015	0.020
64	0.004	0.044	0.001	0.001	0.009	0.004
68	0.001	0.031	0.001	0.000	0.006	0.003
72	0.005	0.019	0.000	0.000	0.003	0.007
76	0.001	0.011	0.000	0.000	0.002	0.001
80	0.003	0.006	0.000	0.000	0.001	0.001
84	0.002	0.007	0.001	0.000	0.002	0.000

Note: Hours category with hours $= l$: $l - 2 \leq h < l + 2$)
l=4: lowerbound 0, l= 84: upperbound ∞

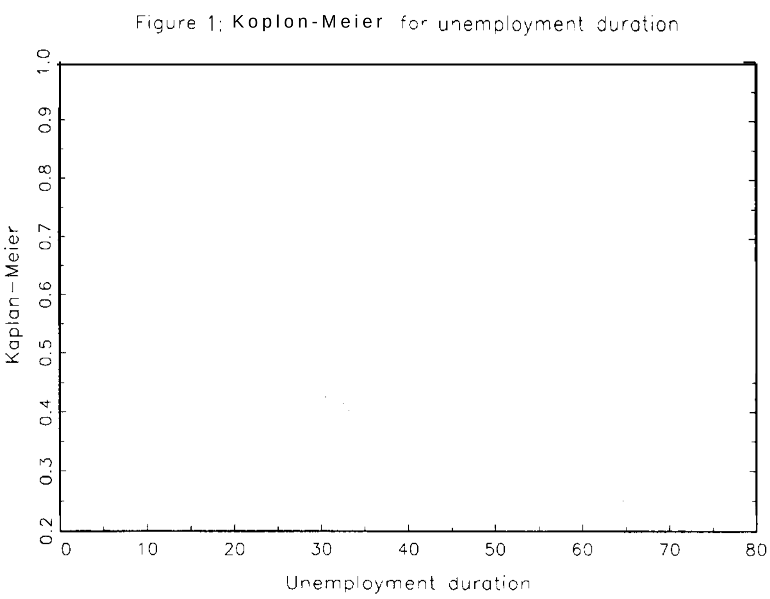

Figure 1: Kaplan-Meier plot of data unemployment duration

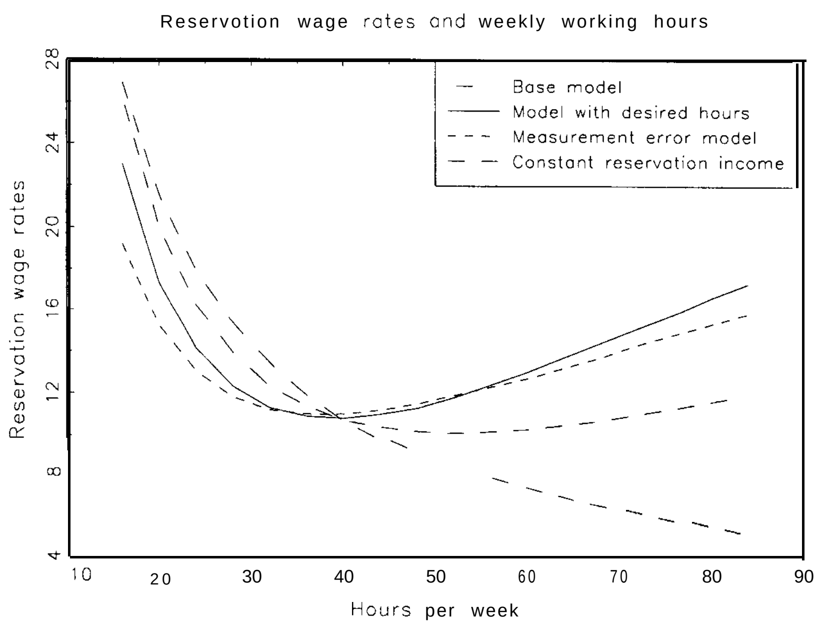

Figure 2: Reservation wage rate as a function of hours

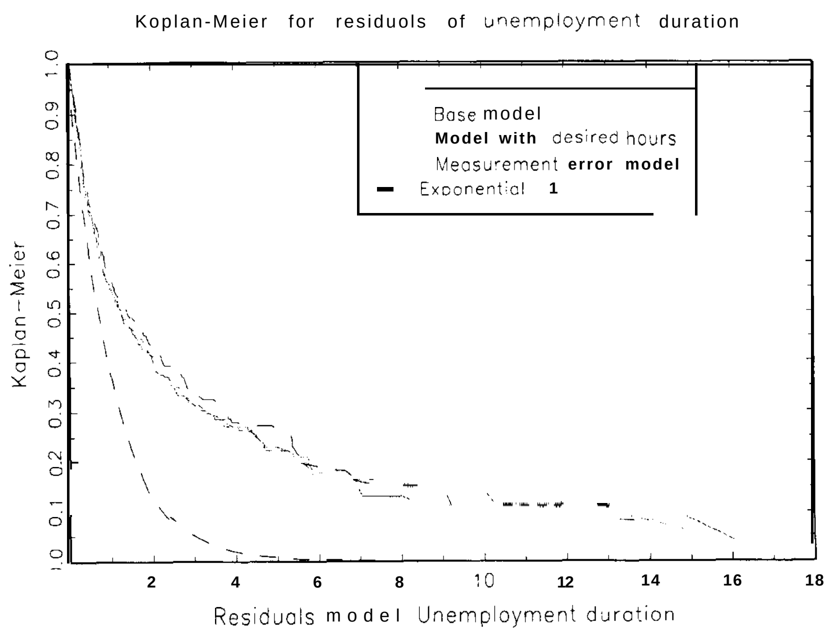

Figure 3: Kaplan-Meier plot of the residuals for unemployment duration

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A Additional details of likelihood contributions

In this appendix we provide the details of the derivation of the joint density of observed wages, hours and desired hours, conditional on unobserved heterogeneity.

In section 2.2 it has been assumed that accepted wages are observed with a log-normally distributed measurement error. Formally, the relation between the observed wage w_{obs} and the offered wage w reads

$$\ln w_{obs} = \ln w + m, \text{ conditional on } w > \xi_l(q),\ h = h_l,\ m \sim N(0, \sigma_m^2) \tag{A.1}$$

in which m represents measurement error.

(A.1) implies that the density of the observed wage, conditional on the offered wage, reads

$$f_{obs,c}(w_{obs}|w) = \frac{1}{\sqrt{2\pi}\sigma_m w_{obs}} \exp\left\{-\frac{1}{2\sigma_m^2}[\ln w_{obs} - \ln w]^2\right\} \tag{A.2}$$

The density of an acceptable wage offer conditional on hours being equal to h_l can be derived from the job offer density:

$$\frac{f(w)}{\bar{F}_l(\xi_l(q))}, l = 1, ..., L, w > \xi_l(q), \tag{A.3}$$

The likelihood contribution of an individual with observed unemployment duration t_u and job characteristics w_{obs} and h_l, conditional on unobserved heterogeneity, can be formed by multiplying the job offer arrival rate $\lambda(q)$, the probability p_l that hours h_l are offered, the job acceptance probability $\bar{F}_l(\xi_l(q))$, the survival probability exp $\{-\theta(q)t_u\}$, the densities for the wages (A.2) and (A.3), and the density of desired hours $r(\tilde{h}|w, q)$. This yields the following expression:

$$\lambda(q)p_l\bar{F}_l(\xi_l(q)) \exp\{-\theta(q)t_u\} f_{obs,c}(w_{obs}|w)\frac{f(w)}{\bar{F}_l(\xi_l(q))} r(\tilde{h}|w, q) \tag{A.4}$$

The accepted wage w is treated as latent and is integrated out of (A.4). In a final step, unobserved heterogeneity is integrated out. This results in the likelihood contribution (2.8).

For employed individuals for whom we observe job characteristics and desired hours we can determine the likelihood contribution by intregrating (2.8) over duration t_u. This results in the following likelihood contribution:

$$f(w_{\text{obs}}, h_l, \tilde{h}) = \int \frac{\int_{\xi_l(q)}^{\infty} f_{\text{obs,c}}(w_{\text{obs}}|w) f(w) p_l r(\dot{h}|w, q) dw}{\sum_{j=1}^{L} p_j \bar{F}_j(\xi_j(q))} g(q, \Sigma) dq \qquad \text{(A.5)}$$